Interoperability of Minutiae

When biometric interoperability is discussed it is critical to separate the issue of data exchange formatting from the issue of the usability of the information exchanged for biometric matching. Many standards developed for the common formatting of biometric data have been used successfully for years such as ANSI/NIST-ITL 1-2000 that addresses the interchange of fingerprint data. The issue of determining if the data exchanged is of sufficient quality to be of use in making biometric comparisons has not been addressed by most of the biometric interchange standards other than those based on images. For fingerprints, the most comprehensive attempt to address this issue is the NIST Fingerprint Image Quality (NFIQ) method discussed in NISTIR 7158. This measurement method can be used on the fingerprint image to determine it's usability for fingerprint matching. No equivalent measurement method exists for the evaluation of fingerprint templates.

The two most common motivations for using a template instead of an image are first, potential space savings, and second, prevention of identity theft. With the possible exception of a few very rare cases, minutiae-based templates are significantly smaller than images. A typical WSQ-compressed, 500 dpi, 8-bit grayscale flat index finger image will occupy approximately 10 Kbytes, while a high-quality template requires about 2 Kbytes. In situations where storage is at a premium, templates may be the preferable choice for accommodating such constraints.

However, (unencrypted) minutiae templates provide only a nominal increase in security with respect to protecting privacy or preventing identity theft. For example, it is possible, given a set of minutiae, to construct an artificial fingerprint image that would exactly reproduce that set of minutiae. In other words, the synthetic image could provide as accurate a match as the original template. In many cases, because the synthetic image can be generated to have "perfect" characteristics, a synthetic image constructed from true minutiae could provide better accuracy than even a second impression from the original finger. Similarly, any template algorithm that can be reversed in such a manner only provides protection from the most casual of attacks.

Exchange of minutiae data has been standardized by ANSI-INCITS 378-2004. This standard is substantially the same as the ISO 19794-2 SC37 standard on the same topic that is currently in process of development. The interoperability for the exchange of minutiae data between vendors will be tested by NIST during the MINEX04 test: http://fingerprint.nist.gov/minex04/. Although conformance testing standards are currently under development in M1.3, no conformance test for this minutiae standard is currently available. .

The standard provides three possible levels for minutiae templates:

1) Minutiae location and direction and type
2) Minutiae location and direction and type plus ridge counts between minutiae.
3) Minutiae location and direction and type plus ridge counts between minutiae and/or core and delta locations.

Testing by other organizations suggests that the level 1 template will not provide sufficient accuracy. The richer level 3 template is likely to provide sufficient information for biometric matching but there is no evidence to indicate that it will or will not be interoperable. The lack of interoperability, if it occurs, will not be caused by data formatting issues. This issue is adequately addressed by the standard. Interoperability is likely to be compromised due to the different vendors extracting both different minutiae and different minutiae locations for the common minutiae from the same fingerprint image. Minutiae extraction software identifies both true minutiae and false minutiae. The number of false minutiae identified, depends on the quality of the fingerprint image, the image processing used by the vendor prior to minutiae extraction, and the minutiae extraction algorithms used.. The ability of COTS software to extract a sufficient number of common true minutiae, with accurate locations, and without excessive false minutiae has never been tested. At the present time we have a standard, ANSI-INCITS 378-2004, that provides the data exchange format capability for interoperability, but we cannot provide any testable measure of the usability of the template for biometric matching. At the completion of the MINEX test, in late 05, the level of interoperability that can be achieved using minutiae will be known and predicting the accuracy of a milt-vendor system using templates will be possible.

At the present time, using a minutiae based template system carries an unknown but significant risk of producing much lower matching accuracy rates than would be observed with the use of fingerprint images. The usability of fingerprint templates generated by different vendors' biometric matching algorithms has not yet been tested. The accuracy for 18 different vendors has been measured for image-based fingerprint matching and NFIQ can be used to evaluate the suitability of fingerprint images for biometric matching. At this time finger images should be employed for biometric matching until MINEX04 is complete and those results illustrate that the minutiae can be successfully used for interoperability and matching.
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